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ELK Population Dynamics & Breeding Biology

PROGRESS REPORT 1992

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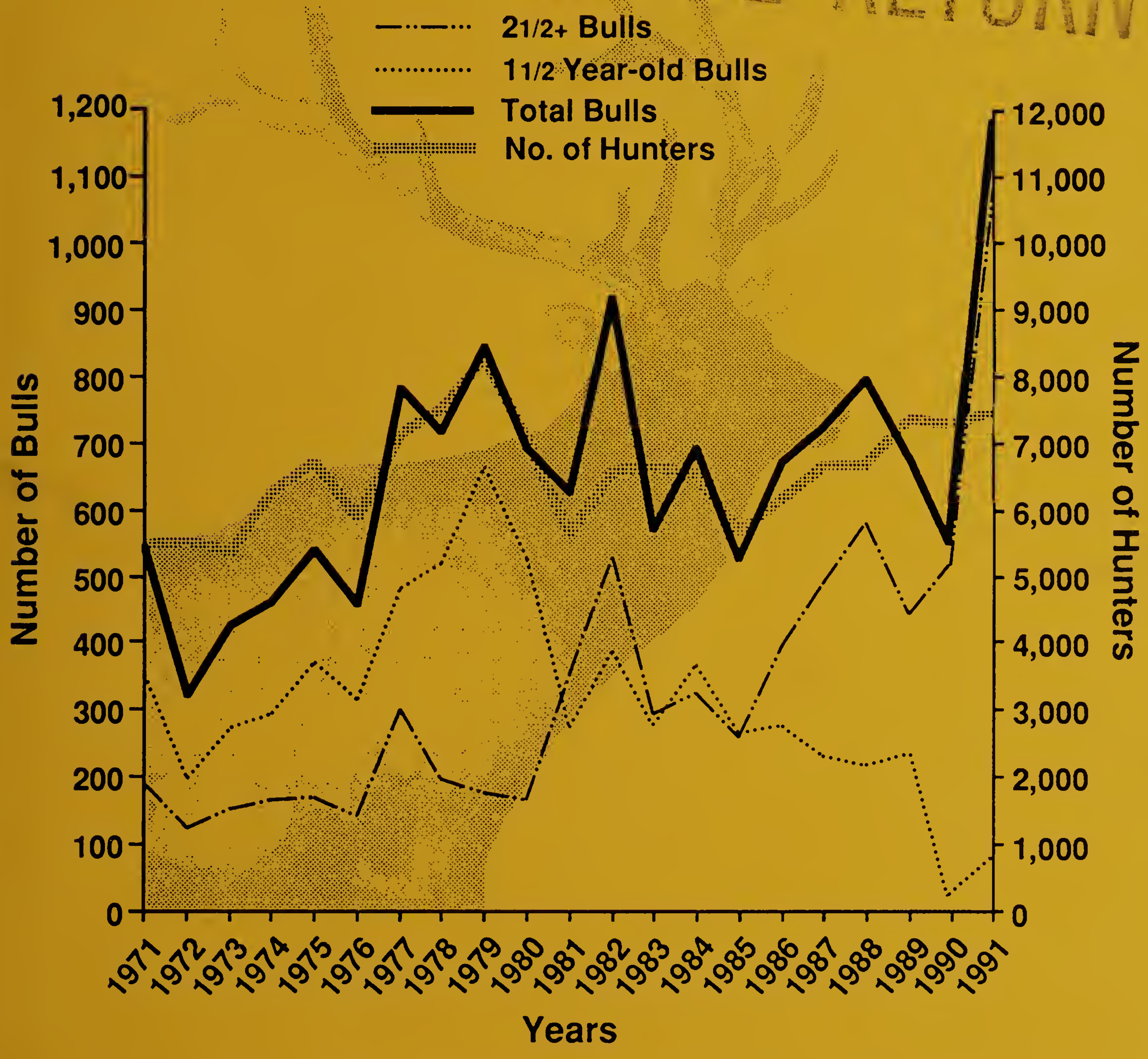

Number of hunters and harvest of total bulls, yearling bulls and 2+ year-old bulls in Gravelly-Snowcrest hunting districts as estimated by the statewide hunter questionnaire, 1971-1991.

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JOB PROGRESS REPORT

RESEARCH PROJECT

STATE:	Montana		
PROJECT NO:	W-100-R-5	TITLE:	Statewide Wildlife Research
SUBPROJECT NO:	I	TITLE:	Big Game Research
STUDY NO:	BG - 2.1	TITLE:	Elk Ecology Studies
JOB NO:	1	TITLE:	Elk Population Dynamics and Breeding Biology

Period Covered: July 1, 1991 - June 30, 1992

Prepared by: Kenneth L. Hamlin

Michael S. Ross
Michael S. Ross

Approved by: Terry N. Lonner
John P. Weigand
Donald A. Childress

Date: December 31, 1992

Since this is a Progress Report only, results presented herein are not necessarily final and may be subject to change. For this reason, the information contained in this report may not be published or used for other purposes without permission of the Director.

OBJECTIVE

Assist with the compilation and evaluation of existing databases on several elk herds in Montana. Coordinate and recommend research, management studies, and procedures which will provide for more effective management and a better understanding of elk population dynamics.

METHODS

Published and unpublished data continued to be compiled and evaluated. Meetings with MDFWP biologists, wildlife managers, and planners were continued to obtain their viewpoints and knowledge. This information will continue to be synthesized with the aid of the computer programs SAS, POSIM (Mooney and Lonner 1978), and TELDAY (Wildlife Div. MDFWP 1986) to better organize existing databases and evaluate elk management in Montana.

RESULTS AND DISCUSSION

Coordination with Montana Department of Fish, Wildlife and Parks' biologists and game managers was continued to address future management and research needs for elk. Response was given to a variety of requests for information and/or advice on elk management and research. Known-age elk jaws for check station aging boards were provided for several people.

No further progress was made during the period in analysis of data on the Northern Yellowstone Elk Herd collected during the 1960s by Ken Greer.

Meetings on the subject of elk vulnerability with U.S. Forest Service and state personnel from Montana, Idaho, Oregon, and Washington were attended at La Grande, Oregon and Yellow Bay, Montana. Also, a meeting of Montana and Idaho personnel about management of border area wildlife, including elk, was attended.

RECOMMENDATIONS

This aspect of the overall study should be continued in accordance with the objectives and methods stated in the 1988-1992 Application for Federal Aid for this research effort.

LITERATURE CITED

Mooney, E. L. and T. N. Lonner. 1978. POSIM-1 General Wildlife Population Simulator. Pps. 631-640. In H. J. Higland, N. R. Neilson and L. G. Hulls Eds. Proc. 1978 Winter Simulation Conf., Miami, FL., Dec. 4-6, 1978. 1,051 pp.

SAS Institute, Inc. 1985. SAS user's guide: statistics. Version 5 ed. SAS Inst., Inc., Cary, NC. 956 pp.

Wildlife Division. 1986. TELDAY user's manual. Montana Department of Fish, Wildlife and Parks, Helena. In Revision.

JOB PROGRESS REPORT

RESEARCH PROJECT

STATE: Montana
PROJECT NO: W-100-R-5 TITLE: Statewide Wildlife Research
SUBPROJECT NO: 2 TITLE: Big Game Research
STUDY NO: BG - 2 TITLE: Elk Ecology Studies
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INTRODUCTION

Elk (*Cervus elaphus nelsoni*) management in Montana has been primarily directed toward increasing elk numbers and maintaining a diversity of choice in elk hunting opportunity. In earlier years, diversity of choice was maintained by either-sex elk hunting. In 1963, 67% of Montana's hunted elk habitat was open to season-long either-sex hunting. More recently, season-long either-sex hunting has declined (to 1% of elk habitat by 1985), and diversity of choice has been maintained by a diversity of regulations among hunting units (Wildlife Division, MDFWP, 1985).

The any antlered bull regulation remained widespread, but an increasing number of hunting units were restricted to branch-antlered bull hunting. In 1981, only one hunting district (HD 324) was restricted to branch-antlered bull harvest. By 1985, seven hunting districts had branch-antlered bull regulations and two were branch-antlered bull after an either-sex quota was reached. In 1989, 28 hunting districts and portions of 2 others had branch-antlered bull regulations.

In 1990, a brow-tined bull regulation was implemented in areas that previously had a branch-antlered bull regulation. Thirty hunting units had brow-tined bull regulations in 1990 and 37 in 1991. This regulation is an attempt to reduce the degree of illegal mortality experienced under branch-antlered bull management (Hamlin and Ross 1990b, DeSimone and Vore 1992).

Depending on the area, the branch-antlered bull regulation resulted either from concern over the long-term biological effects of yearling bulls siring most of the calves or from some hunters wanting to harvest a larger bull. Prior to implementation of this regulation, the MDFWP cautioned hunters that few bulls older than 2 years of age would be harvested.

Low observed calf:cow ratios in the Gravelly-Snowcrest Mountains during the winters of 1979-80 and 1980-81 (18-35 calves:100 cows versus 55-68:100 during 1970-75, Chrest and Herbert 1980 and 1981), coincided with low antlered bull:cow ratios. Available evidence suggested that low proportions of mature bulls in elk populations might negatively affect calf production and/or survival and population size (Hines and Lemos 1979, Prothero et al. 1979, and Smith 1980). Concern over the observed low calf:cow and bull:cow ratios resulted in changes in hunting regulations in HD 324 during 1981. The early archery season was eliminated, and the kill during the general elk season was limited to branch-antlered bulls. The branch-antlered bull regulation was also implemented in HDs 323, 326, and 330 during 1983 and HD 325 and the northern portion of HD 327 during 1987. The early archery season was restored in HD 324 during 1988.

This study was initiated in January 1984 to assess the role and importance of various hunting strategies on elk population characteristics and dynamics. Emphasis has been directed toward breeding biology, reproductive success, calf recruitment, seasonal distribution, movements, and habitat use. Effect of various hunting strategies on hunter success, attitudes, and other factors was also evaluated.

OBJECTIVES

1. Determine the effects of alternate hunting regulations and harvest rates on elk population dynamics and habitat use.

2. Test the hypothesis that when mature bulls (2+ years) comprise less than 5% of an elk population during the breeding season, the net reproductive success will be less than when compared to when the population has greater than 5% mature bulls.

3. Assist biologists with evaluation of existing elk population data and utilize the results from this study to better understand elk population dynamics and manage harvests.

STUDY AREA

Because of low observed calf:cow and bull:cow ratios, the popularity of the area for hunting, and the changes in hunting regulations already in place, the Gravelly-Snowcrest Mountains in southwestern Montana were selected as the primary study area. In 1984 and 1985, work was concentrated on elk that winter on the Madison-Wall Creek Wildlife Management Area (WCWMA) south of Ennis. Elk that winter in the Cherry-Morgan area just north of Wall Creek were also captured and marked. The physiography and vegetation of this area have been described by Eustace (1967) and Gniadek (1987).

In 1986, work was expanded to include elk that wintered on the Blacktail Wildlife Management Area (BTWMA) southeast of Dillon. In spring 1989, the study area was expanded by marking elk that winter on the Robb-Ledford area, the Warmsprings area, and the Basin-Sage Creek area (Hamlin and Ross 1990a). The expanded study primarily involves current MDFWP hunting districts 323, 324, 325, 326, 327, and 330 (Fig. 1).

METHODS

Methods employed were similar to those reported previously (Lonner and Schladweiler 1987, Hamlin and Ross 1990b).

During February 1992, capture of 105 elk (45 at WCWMA and 60 on the BTWMA) was accomplished by helicopter drive-netting. As in 1990 and 1991, we were successful in concentrating our capture effort on 9-month-old calves. Seventy-eight of the 105 elk (74%) were calves.

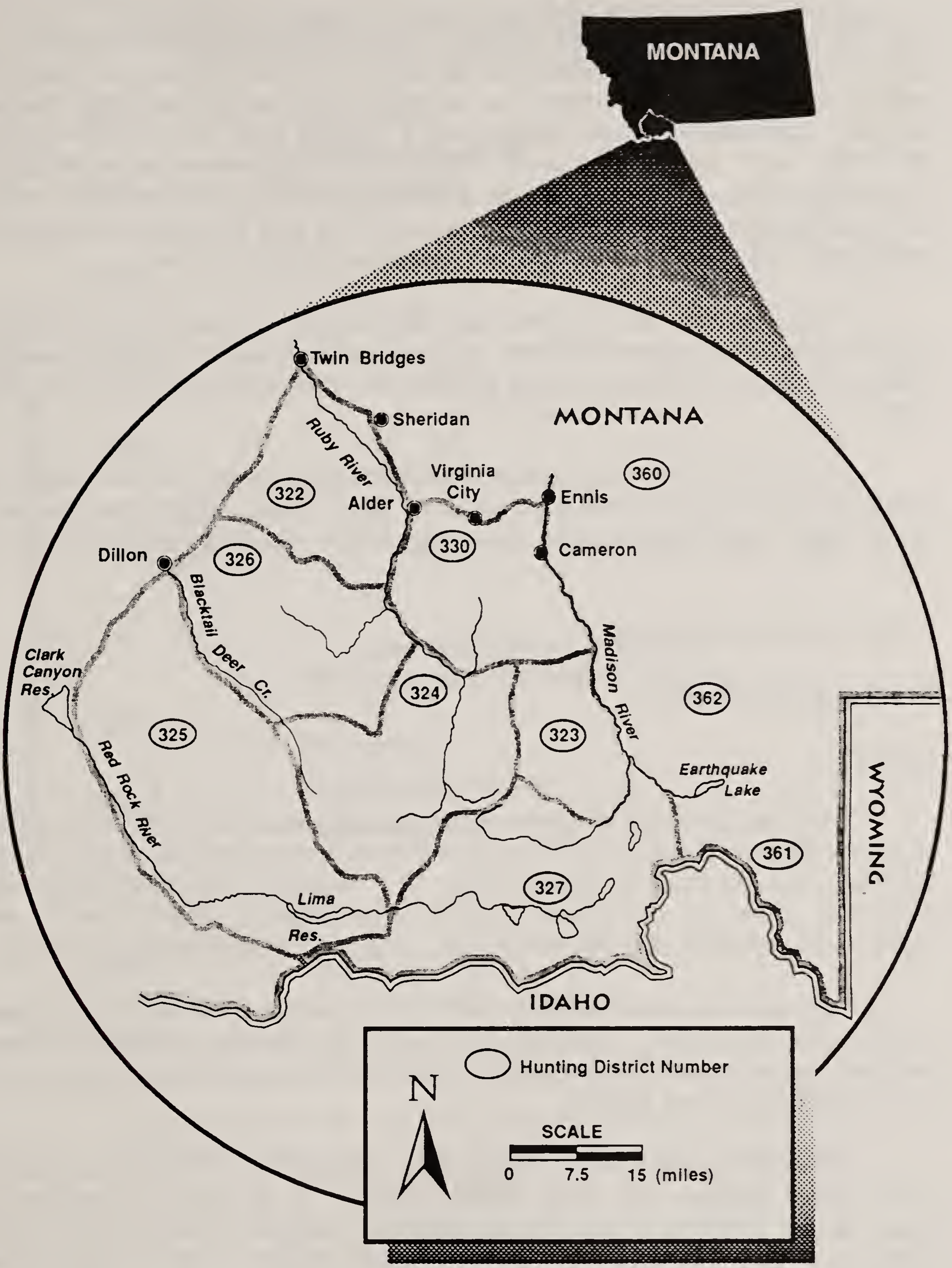


Figure 1. Location of hunting districts within the Gravelly-Snowcrest study area.

A total of 18 male and 17 female calves were captured on the WCWMA and 17 male and 26 female calves on the BTWMA. The male calves were all equipped with black PVC radio-transmitter collars and ear tags. All female calves were fitted with individually recognizable neckbands and eartags, except one that died from trapping injuries. Additionally, 9 adult females and 1 yearling male were captured on the WCWMA, and 15 adult females and 2 yearling males were captured on the BTWMA. One yearling male and 16 adult females were equipped with radio-transmitter collars. One yearling male and seven adult females were fitted with individually recognizable neckbands. One yearling male and female died from trapping injuries.

An incisor was collected from each elk older than 2 years during 1991-92 at check stations or from other mortalities. Age was assigned based on cementum analysis (Gilbert 1966) and compared to ages assigned by eruption-wear (Quimby and Gaab 1957).

As in prior years, blood samples collected from captured elk were tested for pregnancy using level of protein B (Sasser et al. 1986). Also, various blood chemistry, whole blood, and disease parameters were measured at the MSU Veterinary Research Lab.

RESULTS AND DISCUSSION

Population Characteristics

Numbers

Trends in numbers of elk observed during aerial surveys from 1947 to the present on the WCWMA area and from 1948 on the BTWMA area indicated an increase on both WCWMA and BTWMA in 1991-92 (Fig. 2). However, we believe that lower proportions of animals were observed during census flights in 1990-91 than in other recent years, especially in the BTWMA-Robb-Ledford area (Hamlin and Ross 1991).

Early snows and cold weather forced elk to the vicinity of the winter range during early hunting season 1991. Conditions for viewing elk remained excellent post-season and counts during winter 1992 probably recorded higher than usual percentages of total elk observed (Fig. 2 and Table 1).

Population estimates made using hunting mortality rate of marked animals and other factors (Hamlin and Ross 1990b) indicated a post-season population of approximately 7,303 elk in the Gravelly-Snowcrest complex during 1991-92. This compares to 9,819 estimated for 1990-91, 7,360 in 1989-90, 6,295 in 1988-89, and 5,060 in 1987-88. The post-season census flights totaled 7,316 elk. Although counting conditions were good, it is unlikely that 100% of the elk were counted. Therefore, it is

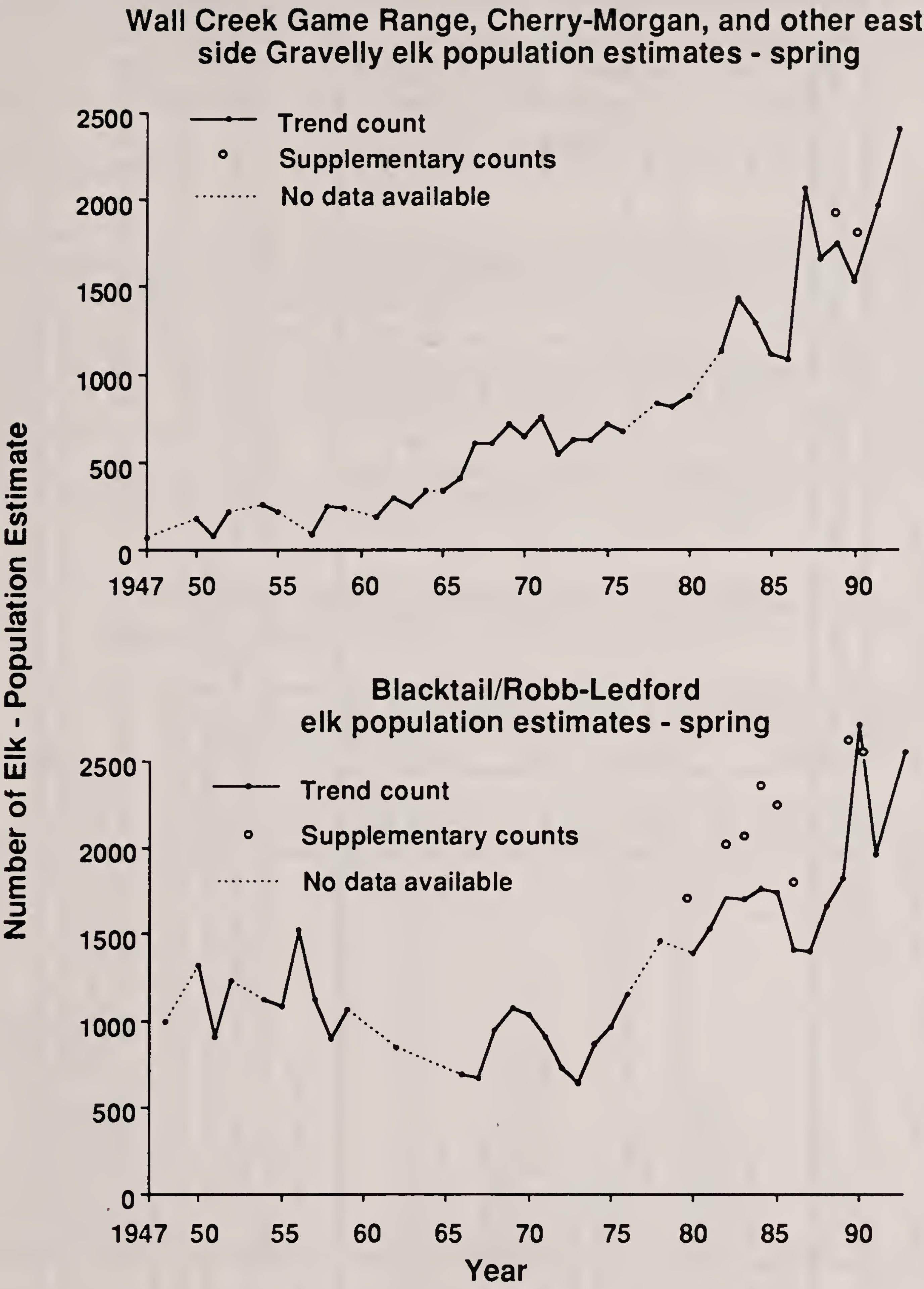


Figure 2. Trends in numbers of elk observed during winter aerial surveys of the eastside of the Gravellys area and the Blacktail-Robb-Ledford Wildlife Management Areas, 1947-1992.

Table 1. General locations of elk observations and counts for the winters of 1984-85 through 1991-92.

	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91^{b}	1991-92
Axolotl Lake Area	33	97	80	14	0	0	114	218
Cherry-Morgan Creeks Area	414	150	623	233	260	512	444	791
Madison-Wall Creek Game Range	664	805	1,233	1,182	1,401	880	1,249	1,373^{c}
Missouri Flats-West Fork Madison	---^{a}	35	134	132	91	157	162	32
Total for east side of Gravellys	1,111	1,087	2,070	1,661	1,752	1,549	1,969	2,414^{c}
North Centennial Valley	57	19	62	57	0	0	0	0
South Centennial Valley	--^{a}	---^{a}	---^{a}	---^{a}	---^{a}	310	93	71
Blacktail Game Range & Robb-Ledford Creeks	1,740	1,416	1,403	1,663	1,820	2,719	1,918	2,662^{d}
Greenhorn Mtns. & Lower Ruby River	---^{a}	323	432	463	317	458	418	514
Little Sage-Basin Creeks Area	---^{a}	199	365	322	490	537	442	840^{e}
Blacktail Ridge	---^{a}	---^{a}	189	273	425	493	284	815^{f}
Total for Blacktail-Centennial-Greenhorn Area	1,797	1,957	2,451	2,778	3,052	4,517	3,155	4,902^{def}
Grand Total	2,908	3,044	4,521	4,439	4,804	6,066	5,124^{b}	7,316^{g}

[a] No flights were made over these areas

[b] Because of wide dispersal during winter 1990-91, a greater than usual portion of the elk were missed during aerial counts.

[c] A group of 477 elk counted near Wall Canyon are not included because we believe they were elk normally on the Sun Ranch, east of the Madison River. An ongoing late-season hunt is believed to have pushed them across to the Gravellys.

[d] This total includes 319 elk believed missed during the first flight and observed on a second flight. The total also includes 145 elk in Moose Creek, near the Sweetwater Hills.

[e] We counted 968 elk here on 12-20-91 with none observed in the Centennial at that time. Some of these elk may have moved back to Corral Creek in the Centennial and Prices Canyon on Blacktail Ridge by 01-18-92.

[f] Of these, 109 observed in Prices Canyon may be Basin-Sage Creek elk based on a neckband observed in the group.

[g] Depending upon the status of possible missed groups and extra Sun Ranch elk above, the total count could range from 6,997 to 7,793.

likely that a post-season estimate of 7,303 for 1991-92 is low. The estimate of 9,819 for 1990-91 was also probably too high. If the estimate for 1991-92 is considered correct, reconciliation indicates that the estimate for 1990-91 should have been 7,173. Further modeling will be necessary to more accurately estimate population numbers.

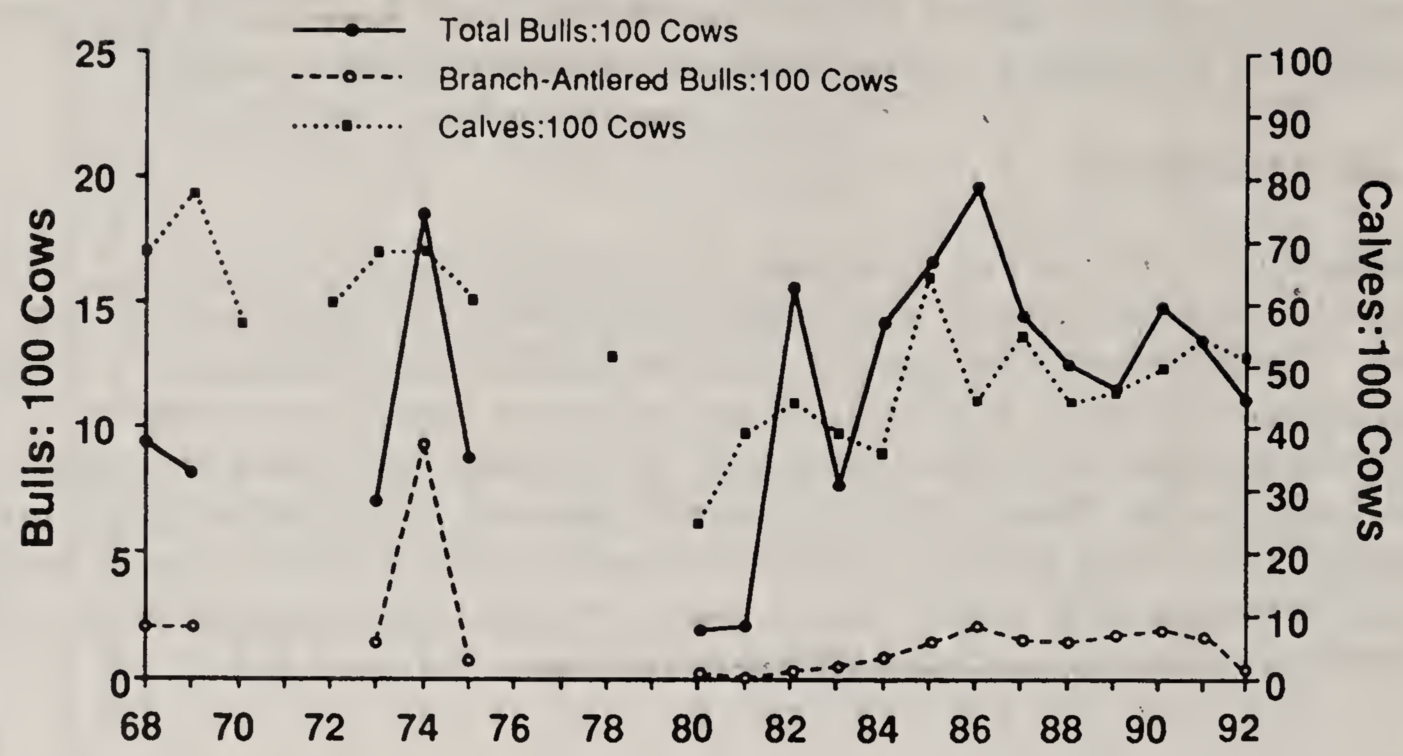
Sex and Age Structure

Classifications - Sex and age classifications made from the ground (Table 2, Fig. 3) indicated higher calf survival than previously on Wall Cr. WMA and the Blacktail WMA. Classifications on the Robb-Ledford area and Blacktail Ridge-Basin Cr. indicated lower calf survival there. Total bull:100 cow ratios were higher than in 1990-91 on Wall Cr. WMA but lower on the Blacktail WMA. Bull:100 cow ratios were very high on the Robb-Ledford area. Most of this improvement probably was related to better survival of yearling bulls. Also, 1990-91 ratios were unrealistically low because of wide dispersal of bulls during the mild winter. Heavy harvest of legal bulls during fall 1991 resulted in declines in BTB:100 cow ratios (Table 2, Fig. 3).

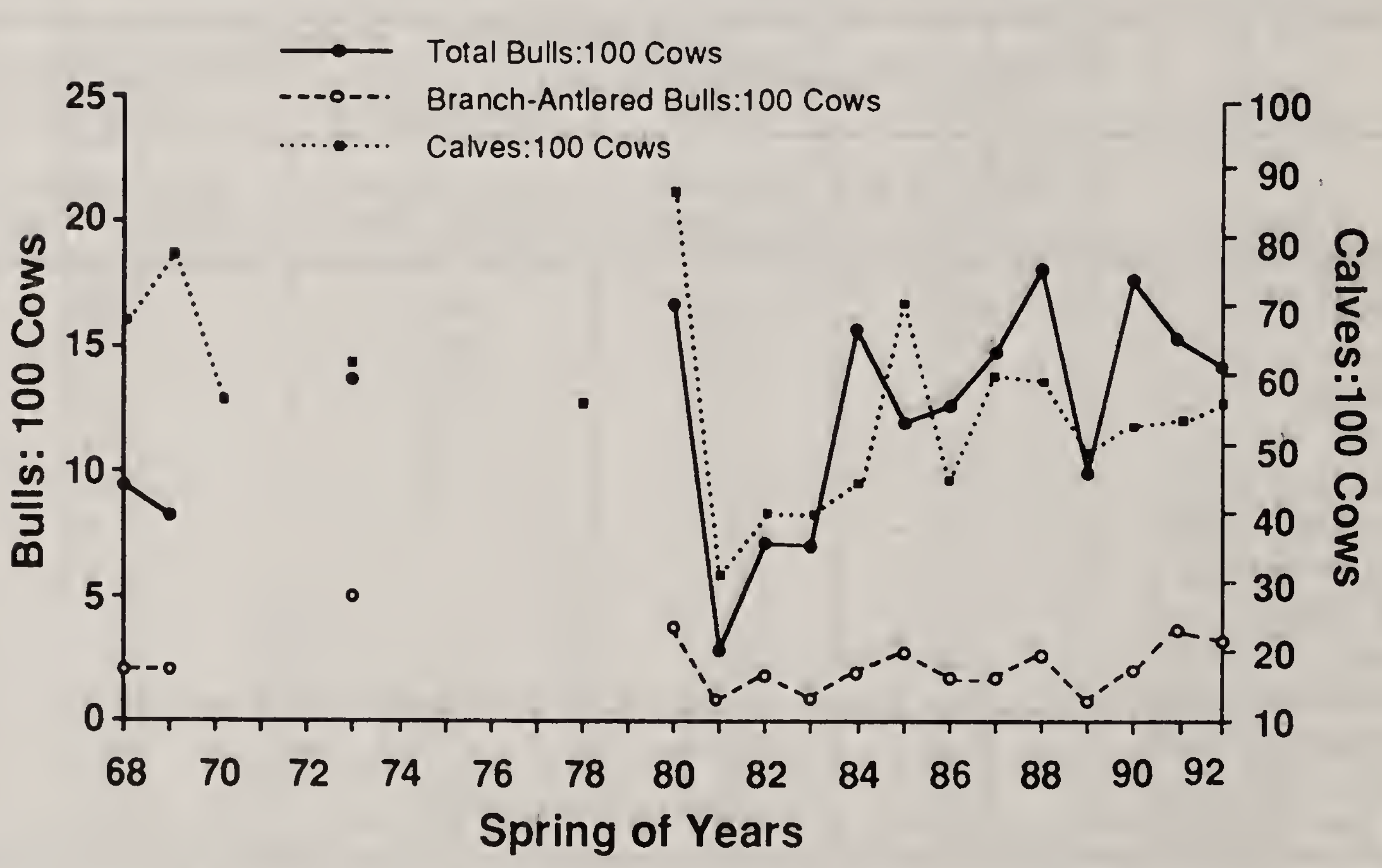
Table 2. Classification results from ground and aerial observations in the Gravelly-Snowcrest Mountains, winter-spring 1992.

Area	Wall Creek WMA	Blacktail WMA	Robb-Ledford[a]	Blacktail Ridge-[a] Basin Cr.
Date	March 9 & 10, 1992	March 3-5, 1992	Late Winter-Spring 1992	Late Winter-Spring 1992
Total	991	1113	407	1060
Cows	582	685	235	714
Calves	326	353	100	272
Bulls	83	75	72	74
Yearling 1X1	57	65	66	64
Yearling 1X2+	9	8	5	9
Raghorn Bulls	4	1	1	1
3+ Bulls	6	1	--	--
Uncl. 2+ Bulls	7	--	--	--
Calves:100 cows	56.0	51.5	42.6	38.1
Percentage bulls	8.5	6.7	17.7	7.0
Bulls:100 cows	14.3	11.0	30.6	10.4
% BA Yearlings	13.6	11.0	7.0	12.3

[a] classifications by Bob Brannon



A. Blacktail Wildlife Management Area



B. Wall Creek Wildlife Management Area

Figure 3. Sex and age structure of elk populations on the (A) Blacktail Wildlife Management Area and (B) Wall Creek Wildlife Management Area during spring, 1968-1992.

Aerial classifications (Table 3) also indicated lower percentages of BTB bulls in 1992 than in 1991. Calf: 100 cow and bull: 100 cow ratios from 1968 through 1992 (Fig. 3) indicate little major change in any ratios over the last few years. Calf: 100 cow ratios for 1985 in Fig. 3 were changed from those listed last year because continuing collection of age structure data indicated that original classifications were probably correct and that this age class was under harvested as yearlings.

The percentage of yearling bulls with branched antlers observed on the winter range increased from around 3% after BAB seasons (1985-1990, Hamlin and Ross 1990b) to about 10% in spring 1991 and 1992 (Table 2, Table 3). Classifications from the ground were a little higher (12.2%) than aerial classifications (9.7%) as might be expected. These percentages are still below the 20-25% expected, however. Five of 20 (25%) radio-collared yearling bulls for which determination was made had some degree (1 inch+) of antler branching.

Age structure of harvested females continued to reconcile well with previous spring calf:100 cow classification (Table 4) except for 1985 (see earlier comment).

Capture and Harvest - As in previous years, reported sex ratio of calves in the harvest and during winter trapping favored females (Hamlin and Ross 1990b). During 1991-92, harvest ratio (44 males:56 females) and winter trapping ratio (35 males:43 females) were shifted toward females, but less so than in 1990-91. We have not determined whether these samples represent the true sex ratio or are biased in some manner by hunter report or trapping technique.

Age structure of 1991 hunter-killed elk (Table 5) indicated relatively few females in the population older than 4 years. Recent higher calf crops have increased the percentage of younger females. The proportion of the male harvest comprised of 3-year old and older males was more than twice as high in 1991 (Table 5) than in 1990 (Hamlin and Ross 1991). Most legal bulls available were harvested in 1991, and age structure portrayed in Table 5 probably represents reality. Older bulls may have been under represented in harvest age structure in earlier samples when a lower percentage of total bulls were harvested. Overall, however, average age of the total bull harvest increased only slightly (Fig. 4).

Some problem continues with aging at check stations. Two and three-year-old males especially have often been aged one year older than incisors indicate. Antler size may influence aging at check stations.

Table 3. Classification results obtained during census flights, winter-spring 1992.

Location	Date	Total Number	Number Classified	Total Bulls	Bulls Classified	Ylg 1x1	Ylg 1x2+	2+ Bulls
Robb-Ledford	01-18-92	537	537	73	73	61	10	2
R-L (Rock Cr.)	01-20-92	319	--	--	--	--	--	--
Blacktail Game Range	01-18-92	1,661	1,661	116	116	104	11	1
Moose Cr. area (Sweetwater Hills)	01-18-92	145	145	24	24	24	--	--
Blacktail Ridge	01-18-92	815	815	97	97	85	11	1
Basin - Sage Creek	01-18-92	840	840	67	67	62	4	1
So. Centennial	01-20-92	71	--	--	--	--	--	--
Greenhorns	01-20-92	299	299	50	50	43a	b	7
Warmsprings	01-20-92	215	215	11	11	11a	b	--
Axolotl Lakes	01-18-92	218	218	17	17	17a	b	--
Cherry-Morgan Cr.	01-18-92	791	791	85	85	80a	b	5
Wall Creek GR area	01-18-92	1,373c	1,373c	88	88	74a	b	14
Sheep Creek - Mile Creek	01-20-92	32	--	--	--	--	--	--
Grand Total		7,316	6,894	628	628	561 (336)[d]	(36)[d]	31

[a] Total unclassified yearling bulls
[b] Branching of yearling bulls unclassified
[c] Excluding 477 elk believed to be from Sun Ranch
[d] Total yearling bulls (classified yearling bulls)

Table 4. Estimated percent yearling cows in autumn populations based on spring classifications and estimated calf: 100 cow ratios the previous spring based on age structure of the female harvest, 1984-91.

	Calves:100 cows Spring classification	Estimated % yearling cows in autumn population based on spring classifications[a]	Estimated % yearling cows in autumn population based on age structure of hunter harvest	Estimated calves:100 cows previous spring based on harvest age structure
1984	38	16.0	17.7	43
1985	66	24.8	15.1	35
1986	42	17.4	18.8	46
1987	56	22.0	21.4	55
1988	50	19.9	22.8	59
1989	45	18.8	19.1	50
1990	49	19.7	21.7	54
1991	53	21.0	18.5	46

[a] The projected % yearlings in the autumn population based on spring calf:100 cow ratios is calculated in the following way:

spring 1984: 38 calves:100 cows = 19 female calves:100 cows
summer-autumn 1984: 19 yearling cows/119 total cows = 0.1597

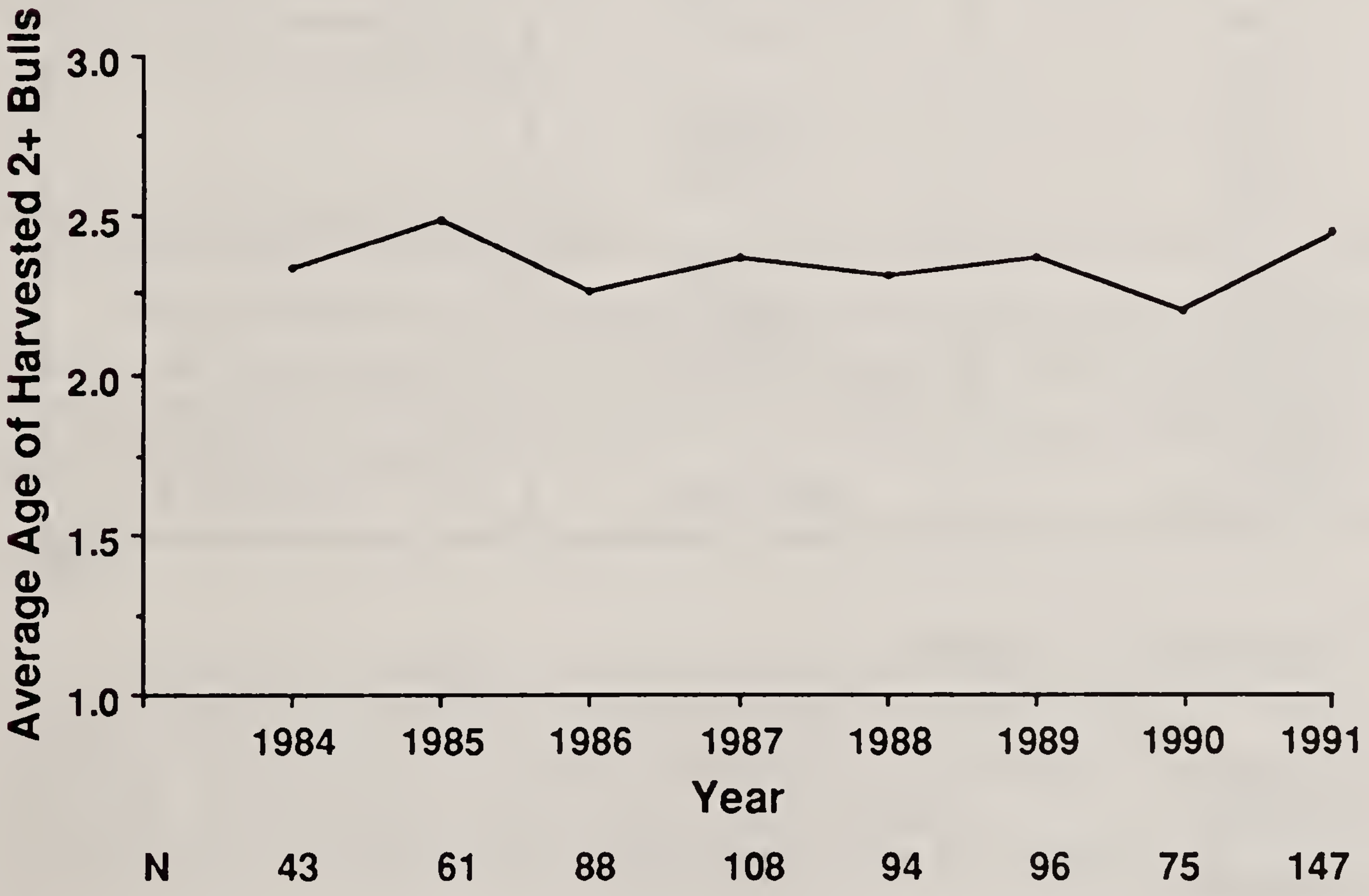


Figure 4. Average age of 2+ year-old bulls harvested in Gravelly-Snowcrest hunting districts, 1984-1991.

Table 5. Sex and age structure of elk checked at hunter check stations and of jaws left in jaw barrels during 1991.

Age	Females	Males
½	56[a]	44
1½	62 (18.5)[b]	--
2½	61 (18.2)	102 (69.4)
3½	44 (13.1)	33 (22.5)
4½	39 (11.6)	9 (6.1)
5½	23 (6.9)	2 (1.4)
6½	16 (4.8)	1 (0.7)
7½	21 (6.3)	
8½	12 (3.6)	
9½	7 (2.1)	
10½	10 (3.0)	
11½	10 (3.0)	
12½	7 (2.1)	
13½	3 (0.9)	
14½	3 (0.9)	
15½	8 (2.4)	
16½	--	
17½	2 (0.6)	
18½	5 (1.5)	
19½	--	
20½	1 (0.3)	
21½	1 (0.3)	
unk. 1+	36	
unk. 2+	--	8
No. 1½+	335 + 36	147 + 8

[a] number

[b] number (%) of aged 1½+ year-olds

Condition Parameters

Weight and Diastema

Field dressed weight of hunter-harvested male and female calves were about 20 and 11 pounds (11 and 7%) less in 1991 than 1990 (Table 6). Similarly, diastema length was 2.6 mm and 3.1 mm (3.0 and 3.6%) shorter for male and female calves in 1991 than 1990 (Table 6). Heart-girth measurements (Smart et al. 1973, Dusek 1990) of calves captured during February (Table 7) also indicated that calves from the 1991 birth year were smaller than those of the 1990 birth year. These same data (Table 7) indicated larger calves on the BTWMA than on the WCWMA in all years 1990-1992.

Table 6. Average weight and diastema length for hunter-killed elk calves in the Gravelly-Snowcrest Mountains, 1984-1992.

	Weight (lbs)		Diastema (mm)	
	Male	Female	Male	Female
1984	200.2 (5)[a]	159.1 (9)[a]	83.7 (6)[b]	79.1 (14)[b]
1985	178.0 (4)	178.7 (6)	81.8 (20)	81.7 (34)
1986	179.0 (8)	156.7 (9)	82.2 (16)	80.5 (35)
1987	172.5 (2)	150.7 (7)	82.1 (21)	84.2 (32)
1988	166.8 (9)	152.2 (10)	85.9 (9)	82.3 (21)
1989	160.8 (9)	146.8 (10)	81.1 (24)	81.7 (26)
1990	183.8 (4)	164.8 (10)	85.8 (8)	85.8 (16)
1991	163.5 (10)	153.7 (14)	83.2 (32)	82.7 (45)

[a] weight in lbs (sample size)
[b] diastema in mm (sample size)

Blood Chemistry and Hematology

Blood chemistry and hematology measurements were made for captured elk by the Montana State Diagnostic Lab in Bozeman. These data were summarized through the 1991 trapping season (Hamlin and Ross 1991). Additional data will be collected before further analysis is conducted.

Disease

All 101 blood samples collected in 1992 were negative for brucellosis. All 98 samples tested for bluetongue and anaplasmosis were also negative. A total of 43 individual elk (43.9%) of 98 tested were positive reactors for leptospirosis in 1992. Thirty-two were positive reactors for serovar bratislava, 17 for tarassovi, eight for autumnalis, five for icterohemorrhagia, and one each for grippotyphosa and hardjo.

Table 7. Heart-girth measurement in inches for elk calves captured during February on the WCWMA and BTWMA.

		1990	1991	1992
Males - WCWMA	$\bar{X}$ =	49.5	50.5	49.4
	n =	17	22	17
	S_x =	2.1	2.1	1.7
	Range =	46.5-54.0	47.0-54.0	46.0-52.0
Males - BTWMA	$\bar{X}$ =	49.8	51.6	50.5
	n =	23	14	17
	S_x =	2.3	2.2	2.3
	Range =	44.5-54.0	48.0-54.5	46.0-54.5
Females - WCWMA	$\bar{X}$ =	48.8	49.9	48.5
	n =	21	30	17
	S_x =	2.7	2.0	2.0
	Range =	40.0-53.0	45.0-55.0	44.5-52.0
Females - BTWMA	$\bar{X}$ =	49.7	50.6	49.6
	n =	23	30	24
	S_x =	1.9	2.2	2.0
	Range =	46.0-53.0	46.0-53.5	46.0-52.5

For all samples tested since 1984, none of 772 have tested positive for bluetongue. Three (0.39%) of 774 elk tested positive for brucellosis, and there were six (0.8%) positive and three suspect reactors of 769 elk tested for anaplasmosis. Excluding serovar bratislava, which was only tested for in 1990 and 1992, 141 (18.5%) of 764 elk had positive reactions for leptospirosis.

Additional diseases tested for only in 1990 and 1992 resulted in the following numbers and percentages of positive reactors: infectious bovine rhinotracheitis, 10 (8.8%) of 114 elk; bovine viral diarrhea, 86 (79.6%) of 108 elk, and parainfluenza 3, 22 (27.5%) of 80 elk.

There has been nothing to indicate that the elk population has suffered major mortality or reproductive problems as a result of these diseases. The positive results can just mean that elk have been exposed to the disease and have developed antibodies against it. However, the three positive reactors for brucellosis were collected and confirmed to be infected with *Brucella abortis* biovar 1 (Hamlin and Ross 1990a).

Antlers

Antler characteristics have been related to nutritional qualities of the diet and physical condition in deer (French et al. 1956, Robinette et al. 1973, Rasmussen 1985). Antler characteristics of yearling male mule deer were closely correlated with fluctuating forage and nutritional conditions (Hamlin and Mackie 1989). There is also evidence that genetics (heredity) makes a significant contribution to antler characteristics (Gottschalk 1972, Harmel 1983). Arguments about the relative contributions of each are unresolved.

There has been some speculation that the branch-antlered bull regulation selected against possibly genetically superior branch-antlered yearling bulls while protecting "inferior" spike bulls. It was believed by some that over the long-term, a reduction in antler quality could occur. This study presents some opportunities to examine this theory, but in a non-controlled rather than controlled environment.

Antlers of yearling males in the Gravelly-Snowcrest Mountains recorded during years and in hunting units where any antlered bull was legal included 73 spikes (1x1) and 31 (29.8%) which had at least one branch an inch or greater on at least one antler. This is considered a high rate of branching (Boyd 1970). Insufficient data were available to examine possible annual differences. Data for other hunting units in Region 3 with any antlered bull regulations (Table 8) indicated substantial variation among years within the same hunting unit and among hunting units within the same years. Branching rate in the Gravelly-Snowcrest area is above the overall average for Region 3, but below that in hunting units 315 and 328. Rates were similar for the Gravellys and hunting unit 300 which is nearest geographically. Branching rate was relatively consistently high for hunting units 315 and 328, consistently low for hunting units 317 and 332, and consistently average for hunting unit 329 (Table 8). Rates for other hunting units were inconsistent. Variation among years was substantial even for consistently high or low hunting units. Consistant differences among areas in antler characteristics could indicate either genetic differences or relative consistency of environmental conditions. Variability in antlers could relate most to environmental variability, but chance and inherent variability of the gene pool could also play a role. These areas where regulations have not selected for or against branching of yearling bull antlers do indicate that substantial natural variation is present, whatever the cause.

To determine if branch-antlered yearlings grow into larger-antlered older adults than spikes do, it would be best to follow individual animals over the course of their life. An attempt will be made to do this with marked individuals, but the heavy harvest rate in the Gravellys and the difficulty of obtaining measurements on many hunter-killed animals make it unlikely that a sufficient sample can be obtained. An attempt can be made to determine if average antler size for the population changes with regulations. The beginnings of this experiment are reported here (Table 9).

Table 8. Percent branching rate of yearling male elk in Region 3 hunting units with any antlered bull hunting regulations. Data based on statewide hunter questionnaire.

	HUNTING DISTRICTS												
Year	314	315	316	317	Total	300	321	328	329	331	332	Total	Grand Total
1991	19 (222)[a]	34 (47)	0 (23)	18 (44)	19 (336)	46 (68)	27 (84)	46 (91)	22 (219)	19 (199)	10 (177)	24 (838)	22 (1,174)
1990	19 (52)	19 (21)	17 (6)	7 (14)	18 (94)	32 (31)	17 (24)	27 (22)	26 (38)	27 (33)	16 (43)	24 (190)	22 (284)
1989	21 (63)	33 (27)	25 (4)	16 (19)	23 (113)	28 (25)	12 (17)	20 (20)	24 (55)	13 (45)	19 (32)	20 (194)	21 (307)
1988	14 (50)	50 (20)	50 (6)	15 (20)	25 (97)	19 (26)	11 (19)	36 (31)	25 (56)	12 (59)	16 (45)	20 (237)	21 (334)
1987	21 (34)	33 (18)	0 (5)	13 (15)	21 (72)	40 (15)	37 (19)	53 (17)	32 (19)	28 (29)	24 (21)	34 (119)	29 (191)
1986	13 (53)	38 (21)	43 (7)	5 (20)	19 (101)	40 (20)	14 (27)	32 (28)	16 (19)	27 (33)	25 (24)	27 (147)	23 (248)
1985	31 (29)	36 (11)	50 (2)	13 (8)	30 (50)	0 (7)	29 (7)	38 (8)	9 (11)	13 (30)	17 (12)	16 (75)	22 (125)
Total	19 (503) 20[b]	35 (165) 35[b]	17 (53) 26[b]	14 (140) 12[b]	21 (863) 22[b]	35 (192) 29[b]	22 (192) 21[b]	39 (217) 36[b]	24 (424) 22[b]	19 (428) 20[b]	14 (354) 18[b]	23 (1800) 23[b]	23 (2,663) 23[b]

[a] Percentage branched (sample size). Branched = 1X2+, based on Gravelly data, 69.9% of 1X3 to 3X3 antlers are yearlings. This percentage was used for these data.

[b] Aggregate percentage.

Table 9. Number of points per side and main beam length of 2 1/2-year-old bulls harvested in the Gravelly-Snowcrest Mountains, 1984-1991. Beam length displayed in millimeters.

		1984	1985	1986	1987	1988	1989	1990	1984-1990 Mean	1991
Points/Side	N	54 (27)[a]	82 (41)	126 (65)	152 (76)	136 (68)	148 (74)	120 (60)		184 (92)
	$\bar{X}$	4.37	4.52	4.76	4.58	4.65	4.53	4.38	4.54	4.49
Main Beam Length	N	53 (27)	80 (41)	126 (64)	144 (74)	125 (66)	143 (66)	118 (59)		176 (92)
	$\bar{X}$	731.7	751.5	765.0	765.2	762.1	745.6	755.6	753.8	730.5
Only the 25% largest each year										
Points/Side	N	7	10	16	19	17	18	15		23
	$\bar{X}$	5.00	5.05	5.38	5.18	5.15	5.36	5.13	5.18	5.11
Main Beam Length	N	7	10	16	18	16	18	15		22
	$\bar{X}$	838.7	881.8	889.1	885.2	877.1	877.7	862.1	873.1	850.3
Only the 25% smallest each year										
Points/Side	N	7	10	16	19	17	18	15		23
	$\bar{X}$	3.79	3.60	3.97	3.71	3.97	3.53	3.40	3.71	3.74
Main Beam Length	N	7	10	16	18	16	18	15		22
	$\bar{X}$	591.9	608.9	634.7	630.9	608.4	612.6	620.5	615.4	608.8

[a] Number of sides (number of individuals) - because of broken antlers, not always twice the number of individuals

Two-year-old bulls measured during the 1984-1990 hunting seasons were all produced under the branch-antlered bull regulation. They were the yearlings left after most branch-antlered yearlings had been shot. Only about 3% of yearling bulls observed after BAB hunting seasons were branch antlered (Hamlin and Ross 1991). Two-year-old bulls measured in 1991were the first produced under the brow-tined bull regulation. A minimum of 10% of surviving yearling bulls were branch-antlered after the 1990 BTB season (Hamlin and Ross 1991). The hypothesis is that with more branch-antlered bulls surviving, average antler size of older bulls should increase. Comparison of antler size of 2-year-old bulls produced under the branch-antlered regulation with those from brow-tined bull regulations will continue as more years of data become available.

For first year comparisons, number of points/side did not increase above the average during branch-antlered bull regulations (Table 9). Also, main beam length was less than the average recorded under branch-antlered bull regulations. In fact, points/side was lower than in five of seven years of BAB regulations, and main beam length was less than all seven years of BAB regulations. With an average potential of only 25-30% of yearlings having branched-antlers, potential changes in the population could be lost in overall population averages and be difficult to detect statistically. We believe that comparison of the 25% largest 2-year-old bulls across years might be a more sensitive indicator. Under BAB regulations, almost no branch-antlered yearlings survived and the 25% largest 2-year-olds would have been mostly spikes as yearlings. With time, up to 30% of surviving yearlings may be branch-antlered under BTB regulations. If genetics plays a large role, the bulls with the 25% smallest antlers each year should all have been spikes, and their size should be more stable among years.

First-year information indicates that any potential genetic contribution to antler size related to size of first antlers may be overwhelmed by environmental-nutritional or random variability (Table 9). The 25% smallest antlered 2-year-old bulls in 1991 (Table 9) were near the long-term average. The 25% largest antlered 2-year-old bulls in 1991, however, were below long-term averages for both points/side and main beam length (Table 9). Points/side were fewer in 1991 than in five of seven previous years, and main beam length was less than in six of seven previous years. Data from more years with BTB regulations will be necessary, however, before we can determine relationships among antler branching rates and various factors.

The first 3-year-olds surviving under BTB regulations will not be measured until autumn 1992. Only small numbers of bulls survive to 3 years in the Gravellys, thus composite samples among years are necessary. The following samples for 3-year-olds are based only on known-age or incisor-aged bulls. Pre-treatment data indicated an average of 5.25 points/side (N=61 antlers, 31 individuals) and an average main beam length of 852.5 mm (N= 61 antlers, 31 individuals) for 3-year-old bulls. One more year of pre-treatment data remains for 4-year-olds. Thus far, 4-year-olds average 5.83 points/side (N=18 antlers) and an average main beam length of 1018.7 mm (N=17 antlers).

Reproduction

Results of blood tests for pregnancy of elk captured in February 1992 have not been received. These results will be included with next year's report.

Mortality

Adult Females

Annual mortality rate for a sample of adult females with functioning radio-transmitter collars was 22.8%, higher than that of 1987-90 (Table 10). Annual mortality attributable to hunting was 21.1%. Over a seven year period, 90% of the annual mortality of adult cows was hunting related. Crippling loss has averaged 10.9% of legal kill.

Causes of mortality were very similar from a larger sample that also included cows with only neckbands and non-functioning transmitters (Table 11). Eleven (6.6%) of 167 known hunting related mortalities of marked adult cows were in Idaho. Archery related kill of elk remains at minor levels.

Adult Males

Ninety-nine percent of known causes of death for marked males was hunting related (Table 11). Of 38 yearling males with functioning radio-transmitter collars that entered the 1990 BTB hunting season, 30 (79.0%) survived. Five (13.2%) were probable illegal mortalities, one (2.6%) was a possible illegal mortality or slipped collar, and two (5.3%) were legally harvested in Idaho. For the 1991 BTB season, 30 (88.2%) of 34 yearling males entering the hunting season with functioning transmitters survived. One of these was subsequently illegally killed on the Sun Ranch late hunt. Two (5.9%) were illegally killed and abandoned during the regular season. Two (5.9%) are still unaccounted for. We have been unable to relocate them since just before hunting season.

For bulls 2-years and older, 28 entered the 1991 hunting season with functioning radio-tranmitter collars. Only one (3.6%) is known to have survived the season. Two (7.1%) have unknown fates because radio contact was lost during the season and has never been reestablished. Of 2+ year-old bulls dying, 19 were rifle kills, 2 were archery kills, 1 was an unreported hunter-kill, 2 were rifle crippling losses, and 1 was shot, dressed out, and abandoned in the field. Seven (6.4%) of 109 known hunting related mortalities of marked adult bulls were in Idaho.

Harvest Surveys and Check Stations

Total harvest of 2+ year-old bulls increased dramatically in 1991 (Fig. 5). An all-time record was set for total bull harvest in Gravelly-Snowcrest hunting units

Table 10. Mortality rates of adult female elk ($\geq$ 1 year) based on a sample with functioning radio-transmitter collars.

Time	N	Total Deaths	Shot	Crippling Loss	Shot - Not Reported	Natural[a]	Unknown	Total Hunting Related
1 June 1984 - 31 May 1985	26	2 (7.7)[b]	1	0	0	1	0	1 (3.9)[b]
1 June 1985 - 31 May 1986	52	4 (7.7)	2	1	1	0	0	4 (7.7)
1 June 1986 - 31 May 1987	59	3 (5.1)	2	0	0	1	0	2 (3.4)
1 June 1987 - 31 May 1988	64	11 (17.2)	11	0	0	0	0	11 (17.2)
1 June 1988 - 31 May 1989	64	11 (17.2)	10[c]	0	1	0	0	11 (17.2)
1 June 1989 - 31 May 1990	79	13 (16.5)	9	1	1	1	1	11 (13.9)
1 June 1990 - 31 May 1991	71	11 (15.5)	5	3	1	1	1	9 (12.7)
1 June 1991 - 31 May 1992	57	13 (22.8)	10	1	1	0	1	12 (21.1)
Total		68	50 (73.5)	6 (8.8)	5 (7.4)	4 (5.9)	3 (4.4)	61 (89.7)

[a] Natural loss includes old age, malnutrition, disease, calving problems, predation, etc.

[b] Number (%)

[c] Includes one archery-kill

Table 11. Causes of mortality for radio-transmitter collared and neckbanded adult elk (≥ 1 year), 1984-1992.

Causes of Mortality	Females	Males			
		BAB Regulations		BTB Regulations	
		1-2 Years	≥2 Years	1-2 Years	≥ 2 Years
Rifle hunting	145 (81.9)[a]	7 (70)	46 (92)	2 (18.2)[d]	33 (85)
Archery hunting	3 (1.7)	-	1 (2)	0	2 (5)
Crippling loss - abandonment (rifle)[b]	11 (6.2)	-	2 (4)	0	2 (5)
Crippling loss - abandonment (archery)[b]	2 (1.1)	-	1 (2)	0	0
Shot and not reported or returned[b]	6 (3.4)	-	-	0	1 (3)
Illegal kill[bc]	-	2 (20)	-	9 (81.8)[e]	1 (3)[f]
Natural deaths[b]	6 (3.4)	1 (10)	-	0	
Unknown	4 (2.3)	-	-	0	
TOTAL	177	10	50	11	39
Total Hunting Related	167(94.4)	9(90)	50(100)	11(100)	39(100)

[a] Number (%)

[b] Because animals with non-functioning radio-transmitter collars and neckbands are included, the number and % in these categories is an absolute minimum.

[c] Because of some problems with collar loss in 1990, illegal kill of yearling bulls may be somewhat overestimated for that year.

[d] These 2 were legally shot in Idaho

[e] One of these occurred after the regular season on a late hunt at the Sun Ranch

[f] Dressed out and abandoned in the field

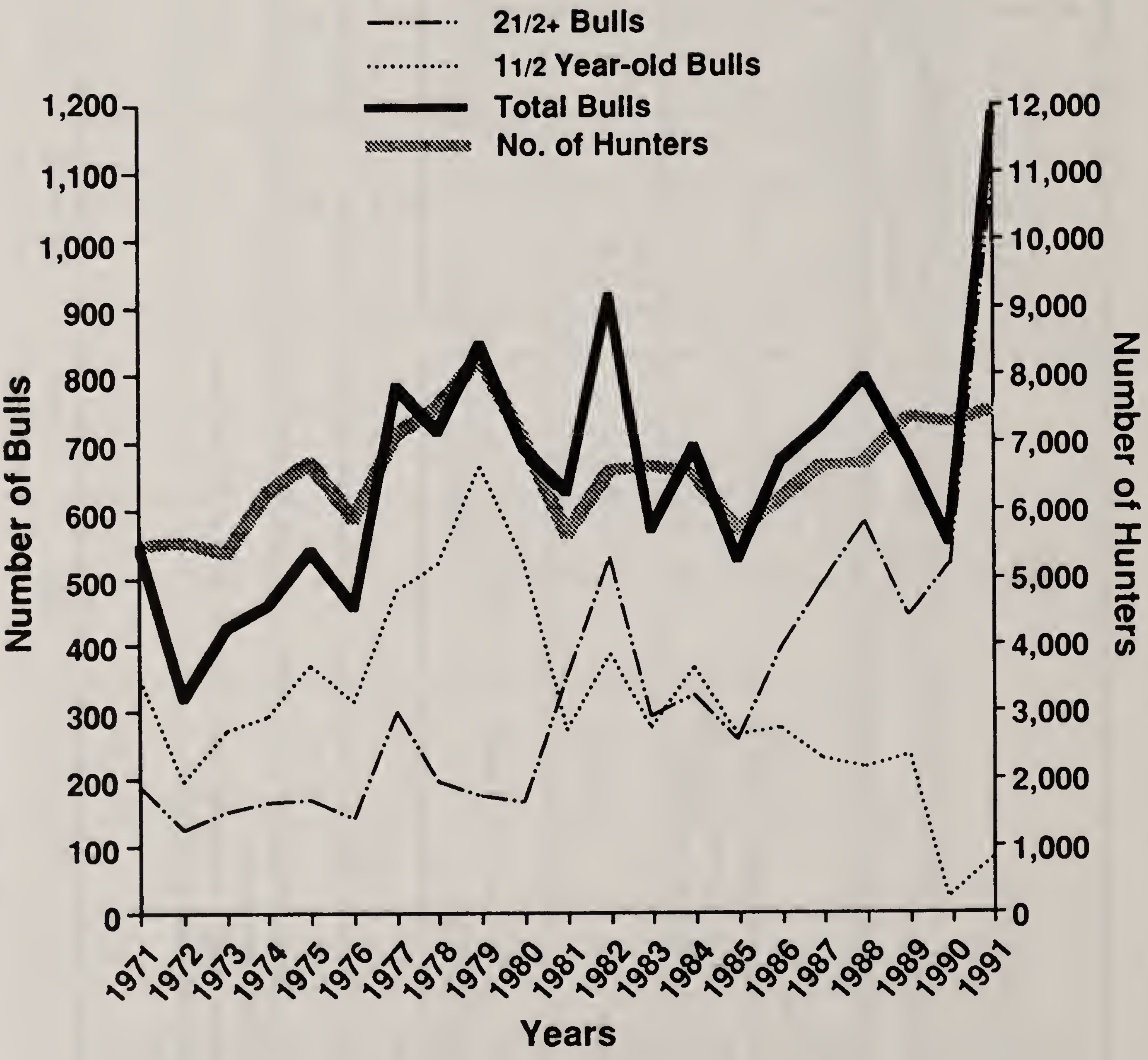


Figure 5. Number of hunters and harvest of total bulls, yearling bulls, and 2+ year-old bulls in Gravelly-Snowcrest hunting districts as estimated by the statewide hunter questionnaire, 1971-1991.

(Fig. 5) and also total antlerless harvest (Table 12). Severe cold and snow during the first week of the season resulted in many elk moving to low, open winter range areas, contributing to heavy harvests. Also, the first year of BTB season in 1990 and mild weather resulted in more bulls than normal being carried over to the 1991 season. Check station data (Table 13) also indicated a record harvest of both bulls and antlerless elk.

Abandoned elk, crippling loss, and/or illegal kill reported at check stations was less in 1991 for both bulls and antlerless elk than in previous years (Table 14).

Table 12. Antlerless harvest in HDs 322, 323, 324, 325, 326, 327, and 330 based on the statewide hunter questionnaire.

Year	No. of Permits	Cows Harvested	Calves Harvested	Total Harvested	Percent Success
1967	125	156	14	170	--
1968	470	290	48	338	72
1969	700	336	71	407	58
1970	735	280	33	313	43
1971	674	192	27	219	32
1972	672	189	60	249	37
1973	475	171	34	205	43
1974	300	92	17	109	36
1975	300	134	18	152	51
1976	350	138	25	163	47
1977	350	184	28	212	61
1978	716	302	39	341	48
1979	576	243	43	286	50
1980	425	195	18	213	50
1981	325	149	20	169	52
1982	725	396	29	425	59
1983	1,275	596	74	670	53
1984	1,775	719	96	815	46
1985	1,950	709	122	831	43
1986	1,500	500	89	589	39
1987	1,500	606	67	673	45
1988	1,750	771	98	869	50
1989	1,950	721	123	844	43
1990	2,000	633	79	712	36
1991	2,000	963	168	1,131	57

Table 13. Season-long results from hunter check stations operated in the Gravelly-Snowcrest Mountains during 1984-1991.

Check Station[a]	Year	No. Hunters	Elk				Mule Deer			White-tailed Deer		
			Males		Females	Calves	Males	Females	Fawns	Males	Females	Fawns
			Yrlng.	2+								
All	1984	3,425	16	40	97	25	154	106	51	26	6	3
	1985	3,124	12	72	110	31	214	121	29	23	5	3
	1986	6,231	33	89	99	30	309	155	46	63	19	22
	1987	5,075	31	93	135	33	376	135	32	49	14	15
	1988	4,944	36	95	178	39	450	112	28	46	19	18
	1989	5,001	26	97	136	58	328	98	20	50	8	13
	1990	4,508	2[b]	81	119	30	312	138	34	31	7	3
	1991[c]	4,087	1	151	174	61	316	162	23	38	20	8
Ruby	1984	1,698	11	23	57	11	127	100	43	20	6	3
	1985	1,623	10	46	82	27	161	105	27	19	5	3
	1986	2,172	11	42	47	14	146	93	30	33	9	18
	1987	2,135	14	36	69	18	175	83	18	26	4	7
	1988	2,096	14	39	62	19	204	62	15	17	6	9
	1989	1,832	4	28	55	27	147	43	9	19	1	3
	1990	1,830	--	34	43	15	167	56	17	17	5	1
	1991	1,522	--	50	51	21	158	74	9	9	1	3
Blacktail Road	1986	1,882	11	20	28	9	102	39	5	24	10	4
	1987	1,930	11	29	38	7	135	38	10	18	10	7
	1988	1,831	11	25	53	3	136	38	9	21	11	7
	1989	2,256	14	40	48	23	137	42	11	26	4	9
	1990	1,781	1[b]	22	34	9	99	66	11	13	2	1
	1991	1,887	1	60	77	21	105	74	9	9	1	3
Ennis	1986	2,177	11	27	24	7	61	23	11	6	0	0
	1987	1,010	6	28	28	8	66	14	4	5	0	1
	1988	1,017	11	31	63	17	110	12	4	8	2	2
	1989	913	8	29	33	8	53	13	0	5	3	1
	1990	897	1[b]	27	42	6	46	16	6	1	0	1
	1991[c]	678	--	41	46	19	53	21	5	7	2	--

[a] The Upper Ruby Creek Check Station was the only one operated each year 1984-1989. In 1984 and 1985, 2-3 other stations were manned on the east side of the Gravellys. In 1986, those were combined into one station at Ennis and a new station was opened on the Blacktail Road south of Dillon.
[b] Illegal kill.
[c] Ennis check station not operated opening day in 1991.

Table 14. Crippling loss, abandoned elk, and/or illegal kill reported at check stations.

Year	Spikes	Legal Bulls	Adults Females	Calves
1988	82	6	27	5
1989	41	2	36	3
1990	28	4	38	3
1991	18	2	19	1

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